Report on the 2011 Stock Assessment Review (STAR) Panel for greenspotted rockfish and blackgill rockfish

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1. Executive Summary

Draft assessments of blackgill rockfish (*Sebastes melanostomus*) and greenspotted rockfish (*Sebastes chlorostictus*) in the Conception and Monterey INPFC areas were reviewed by the STAR panel during August 8-12, 2011. The Panel operated under the Pacific Fishery Management Council's (PFMC) Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012.

The assessment area was limited to Conception and Monterey since the bulk of the populations of the two species off the US coast appear to reside in these areas, and data from Mexican waters are unavailable. The species appear to be common in Mexican waters but the relationship between the populations off US and Mexico is not clear. Blackgill rockfish is a slope species, and greenspotted rockfish a shelf species.

The assessments model blackgill rockfish as a single stock in the assessed area, but treat greenspotted rockfish as two populations north and south of Point Conception based on perceived differences in population biology.

The assessment model estimated that the stock of blackgill rockfish in Conception and Monterey INPFC areas is currently at 30% of its unexploited level, which is above the overfished level of $SB_{25\%}$ but below management target of $SB_{40\%}$ and, therefore, is in precautionary zone.

The assessment models estimated that the stock of greenspotted rockfish is at 37% of its unexploited level south of Point Conception, and at 31% of its unexploited level north of Point Conception. Depletion levels of both stocks were estimated above the overfished level of $SB_{25\%}$ but below management target of $SB_{40\%}$ and, therefore, the stocks are in the precautionary zone.

I agree with the STAR panel conclusion that the blackgill rockfish and greenspotted rockfish assessments constitute the best available scientific information on the status of the species in the assessed area and recommend they be used for status determination and management decision in the Council process. However, the uncertainties in the assessment results are likely to be much greater than explored in the major axes of uncertainty and alternative states of nature.

2. Background

Blackgill rockfish and greenspotted rockfish are components of diverse complexes of rockfish species that occur off the Pacific coast of the USA and Mexico. Many of these are data-poor stocks that have not yet been formally assessed through the Pacific Fishery Management Council's (PFMC) Groundfish Stock Assessment and Review Process.

The blackgill rockfish stock in U.S. waters south of 40° 10' N. latitude is a component of the Southern Slope Complex of rockfishes, and occurs over a depth range of 100m to 600m. It

has been previously assessed in 2005 (Helser 2006) and at a smaller geographic scale in 1998 (Butler et al. 1999). The 2011 assessment covers the same Monterey and Conception INPFC areas included in the 2005 assessment. Over 90 percent of blackgill landings occur in this area. The new assessment builds on the 2005 one by including some additional historic length and age data, and revised historic catch data from the historic catch reconstruction project (Ralston et al. 2010). The model is updated from Stock Synthesis 2 (Ver. 1.19) to SS3 (Ver 3.21fb). The 2005 base model estimated depletion to be 52.3 percent of the unfished spawning biomass, within a range of 36 percent to 67 percent depending upon the assumed natural mortality rate (identified as a key axis of uncertainty for this stock).

Greenspotted rockfish is a component of the Southern Shelf Complex of rockfishes in U.S. waters south of 40° 10' N. latitude, and occupies a shallower depth range than blackgill rockfish. It has not been assessed before other than as part of study on data-poor stocks by Dick and MacCall (2010) using depletion-based stock reduction analysis. The new assessment for greenspotted rockfish was planned because it is at the high end of the PFMC's precautionary range developed by the GMT, and the SWFSC has already expended considerable effort in organizing and analyzing data for this species.

The greenspotted rockfish was assessed as two stocks separated at Point Conception. Hence the STAR Panel had three separate assessments to review over the five days. These assessments will provide the basis for the management of the groundfish fisheries off the West Coast of the U.S. including providing scientific basis for setting OFLs and ABCs as mandated by the Magnuson-Stevens Act.

3. Description of review activities

Draft assessments of blackgill rockfish and greenspotted rockfish in the Conception and Monterey INPFC areas were reviewed by the STAR panel at the Southwest Fisheries Science Center, Santa Cruz Laboratory, from 8 to 12 August 2012. The provisional agenda for the meeting is given in Annex 3 of Appendix 2.

The Review Panel itself comprised the Chair, two reviewers appointed by the Center for Independent Experts (CIE), a Science and Statistical Committee representative, and one representative each from GMT, GAP and PFMC (Appendix 3). The assessment results were presented by the two US technical experts who led the development of the assessments. Several SWFSC staff attended the meeting and contributed constructively to the discussions.

All documentation of the assessments, and additional background documentation, was provided to the STAR Panel on an FTP site in advance of the review workshop, and was sufficiently comprehensive for the job in hand. Some changes to the assessments and inclusion of additional data meant the draft assessments did not fully match the assessments presented at the meeting. The assessment results and background were clearly presented by the experts at the meeting. The Panel requested a number of additional model runs and extraction of other supporting data, and these were done very quickly and led to fruitful discussion that helped to clarify a number of important issues.

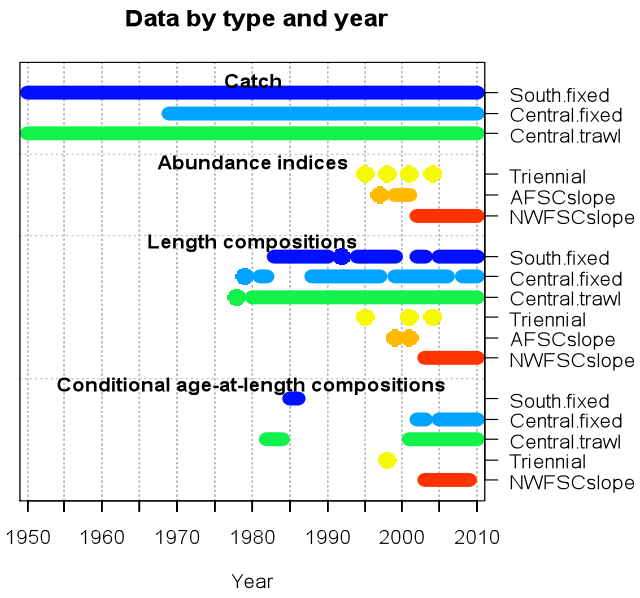
The STAR Panel developed initial drafts of two Summary Reports during the meeting and completed these by correspondence in the following weeks. The following report presents my personal evaluation of the review process together with more extended observations on the data and assessment models that are not necessarily shared with the other panel members. I accept all responsibility for any errors in my report due to misinterpretations of the data or analyses. The report is structured in two sections 4.1 – 4.2 corresponding to the blackgill rockfish and two greenspotted rockfish assessments, and the CIE ToRs related to the data and assessment are covered in each part. The more general CIE ToRs related to the Panel review proceedings and the CIE review process are covered in separate generic sections 5.1 and 5.2.

4. Summary of findings by Term of Reference

4.1 Blackgill rockfish assessment

4.1.1 Quality of data used in the assessments including data collection and processing.

The time series of data available for the assessment are shown in the following plot provided by the STAT:



Landings data

The core data for this assessment, the fishery landings series, are most appropriate for use in the assessment from the 1970s when species reporting commenced. The earlier catch history has been reconstructed as part of a larger exercise to recover historic catch data, but is uncertain for blackgill rockfish due to the fishery expansion into deeper water. Uncertainty in the early catch data translates into uncertainty in historic stock depletion, but the STAT was not able to develop a satisfactory basis for providing bounds to plausible catch histories for sensitivity analyses. The catch data used in the assessment include discards estimates from 2002. Discards prior to then were assumed to be zero due to lack of regulatory incentive to discard. This assumption was supported by the GAP representative at the STAR Panel.

Survey data
The data include three survey index series and associated length compositions which cover varying periods since mid 1990s. The trawl surveys provide very variable abundance indices. The surveys do not sample the main habitat of blackgill rockfish, which occur mainly on non-trawlable habitats. A direct relationship between trawl index and fish abundance (i.e. constant catchability) is not proven. The survey indices have a relatively weak influence on the assessment.

Fishery length composition data
The model uses fishery length compositions for the last 30 years, The composition data are available by gender for a fraction of the samples. The length data over time are increasingly lacking in gender information (and otoliths) due to restrictions on cutting fish at the ports.

Annual sample sizes (number of trips sampled) are relatively stable for central trawl (for which the landings are more consistent since the 1980s) and more variable and sparser for the other two gears since the 1990s when landings declined substantially. The data appear borderline for use in a predominantly length-based model, and indeed the STAT considered the data inadequate to allow annual recruitment deviations to be estimated. Where only a few trips are sampled in a year, the length frequencies may be poorly representative of the overall fishery, particularly given the depth-related trends in fish size.

Age data
Conditional age-at-length compositions were available mainly since 2000 from fishery and survey sources, plus some data from 1980s.

Blackgill rockfish are acknowledged as being difficult to age. Efforts have been made to increase the number of age data available, and to validate the age estimates and examine consistency in ageing. However the variability observed in the conditional age data is likely to include significant component of age errors, particularly for older fish. The age data are available mainly since the 2000s, however the growth parameters are assumed constant over the full period of the assessment which may not be correct given the apparent large stock depletion.

Main signals in the data

For stocks with complex and variable data sets, the STAT should consider tabulating the main features and signals in the data that are influential in modeling decisions and fitting.

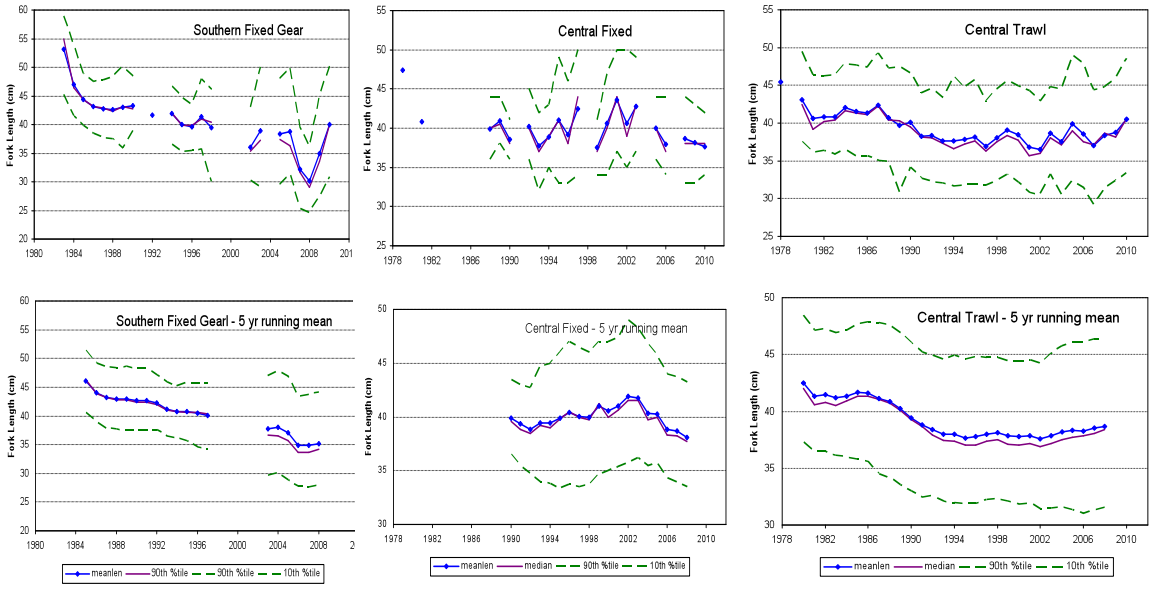
The historical sampling data for blackgill rockfish provide some robust information on aspects of biology important to understanding productivity of the stock:

- Age samples show historical survival of fish to over 60 years of age indicating low rates of mortality.
- Sexual dimorphism in growth occurs.

- Length at age data define the general pattern of male and female growth over the age range containing the bulk of the data, but observations towards the asymptotic part of the growth curve are sparse and this limits the ability to accurately estimate VB parameters K and $L_{infinity}$.
- 50% maturity in females occurs at L= 33cm, equivalent to around 25 years of age;
- Pronounced increase in relative fecundity (eggs or larvae per unit body weight) with increasing fish size.

The main temporal signals for stock development in the data for this stock, which affect the model fit, are:

- Total fishery removals increased from < 100 t up to late 1960s to around 1000t in the late 1980s and have declined to around 150t since the late 1990s when the stricter trip limits were introduced followed by the Cowcod Conservation area (CCA) in 2001.
- It is known that the fishery expanded into deeper water as it developed, which affects size compositions and fishery selectivity.
- Fishery selectivity is expected to have been altered by shifts in fishing patterns following the spatial closures.
- Triennial trawl survey indicates increasing abundance from 1995-2004.
- NWFSC combined shelf slope trawl survey – very variable with no clear trend from 2003-2010
- NWFSC slope survey –also variable with possible increasing trend from 1999-2002
- Commercial and recreational fishery length compositions show a progressive reduction in mean length from the 1980s through the 1990s, caused by a truncation at the upper end of the length compositions and an increasing occurrence of smaller fish. The STAR Panel requested plots of the 10^{th}, 50^{th} and 90^{th} percentiles of the length compositions to clarify the trends (reproduced below)



4.1.2 Evaluation and comment on analytic methodologies.

The SS3 model is an appropriate approach to fitting the available data for this stock, conditional upon identifying model configuration and parsimony appropriate to the quality and information content of the data. The STAT used the SS3 model to fit the commercial and recreational fishery length compositions (and age compositions where available), conditional age-at-length data, and any survey abundance indices, as closely as possible by adjusting a range of parameters such as natural mortality and stock-recruit steepness (fixed externally), and fishery and survey selectivity (e.g. for logistic, double logistic, double normal, as specified by user), growth parameters, standard deviation of length at age and stock-recruit R_0 (estimated internally).

The current assessment addresses most of the comments from the last STAR Panel held in 2005. As recommended, the STAT explored alternative ageing methods, developed new ageing criteria and generated additional age data for the assessment. Improved estimates of maturity and fecundity were obtained. More appropriate definitions of fishery fleets were also developed.

4.1.3 Evaluation of model assumptions, estimates, and major sources of uncertainty; suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.

Model evaluation

By fixing annual recruitments as deterministic predictions from a fitted Beverton-Holt stock recruit function, and assuming constant natural mortality and growth, the assessment is bound to estimate a rapid depletion of biomass as the fishery catches increased in the 1970s. There is no possibility to explain any of the growth in the fishery as resulting from year class variability in earlier years.

A further consequence of fixing the main variables representing stock productivity, particularly year class strength, is that trends in length compositions can only be explained in the model by adjustments to fishery and survey selectivity patterns and blocking of selectivity over time. For example, as in greenspotted rockfish, the lower 10^{th} percentile of the length compositions in several data sets declines over time during the 1980s-1990s, whilst the upper lengths also become more truncated (see Section 4.1.1). Potentially, the increasing prevalence of smaller fish could be a reflection of changes in recruitment rather than changes in fishery selectivity, for example due to reductions in intra-guild predation on pre-recruit fish as the rockfish populations were fished down in the 1980s. Furthermore, the decision of the STAT not to explore the use of other stock-recruit model formulations (e.g. Ricker or more flexible forms such as the Shepherd model) further constrains the range of possible interpretations of the data.

At the request of the STAR Panel, an additional run was carried out estimating annual recruitments from 1970 onwards whilst removing the blocking of selectivity that was done to explain the trends in length compositions. Recruitment estimates were strongly serially

correlated. Increased recruitment in 1990s was presumed to explain part of the trend of declining mean length over time in the fishery (the rest was due to truncation at large size from fishing). The depletion patterns for this run compared to the base run were fairly similar. There is an *a-priori* basis for assuming some change in selectivity, but selectivity will be confounded with recruitment in explaining changes in length. Recruitment was however still fixed up to 1970 and the model estimated a very sharp dip in recruitment in 1971 followed by progressive increase, possibly to compensate for strong year classes in late 1960s not reflected in the fixed values (note Moser et al. 2000 paper shows large larval abundance indices from CalCOFI surveys for some rockfish in late 1960s). The Panel agreed it was important to provide these results in the final SAFE to show that the effect of fixing recruitments was investigated, even if it was not appropriate to estimate recruitment (as was done in 2005 assessment) in the base model due to data limitations. The estimation of annual recruitment should be carried out as soon as the data series are considered adequate.

Against these limitations, the assessment uses the most up-to-date external information to inform the parameters in the model, including the most recent Dorn's prior on the stock-recruitment curve steepness and Hamel prior on *M*.

I agree with the overall STAR Panel conclusion that natural mortality (which strongly covaries with growth parameters and depletion) is a major source of parameter uncertainty in the SS3 model. Bracketing the point estimates of *M* from the Hamel prior (0.063 for females, 0.065 for males) by the standard deviation for the prior to give high (0.086 females, 0.089 males) and low (0.046 for females, 0.048 for males) is a suitable method for giving alternative states of nature. However, it is likely that the true uncertainty in the assessment results is much greater than for this range of *M* alone.

Unresolved problems and major uncertainties

It is not known whether blackgill rockfish in U.S. and Mexican waters are part of the same stock. It is also not known what portion of the blackgill population resides in Mexican waters and what their biological and life history characteristics are.

As with most of the west coast rockfish species, catch history is one of the major sources of uncertainty. Even with the California rockfish catch reconstruction effort reported in Ralston et al. (2010), uncertainty in historical landings remains due to fact that fishing effort exhibited a gradual shift towards deeper waters. Species composition sampling in Southern California began only in the late 1970s, and these compositions were applied to historical landings of multi-species market categories. Therefore, there is the potential to overestimate the historical contribution of slope species (including blackgill) to overall landings of the mixed-species market category (i.e. unspecified rockfish), and underestimate the contribution of shelf species.

The Cowcod Conservation Area is closed to research survey trawling. Different rates of population growth inside and outside the CCA may result in the overall survey indices no longer representing the true population trends.

4.1.4 Determine whether the science reviewed is considered to be the best scientific information available.

There are many limitations imposed on the blackgill rockfish assessment due to deficiencies in the data. It is likely that the assessment provides a correct overall picture of a rapid stock decline as the fishery grew in the 1970s, followed by a more recent growth as the fishery has become more restricted. However, the true trajectory of stock biomass or reproductive output must be considered imprecisely known. Although a number of axes of uncertainty were explored (e.g. *M* and steepness), the assessment is based on only one modelling framework, and sensitivity to some model choices (such as stock-recruit model) were not explored. Also, key estimates such as growth parameters and fishery selectivity from more recent data are propagated back in history, including into a period of uncertain fishery catches.

The pre-STAR document as well as the STAT presentation at the STAR Panel provided extensive information on ecosystem considerations for blackgill rockfish, which (although not explicitly included in the assessment model) provided valuable background information and outlined potential areas of research to pursue in the future while moving toward ecosystem-based management.

4.1.5 Specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.

I agree with the STAR Panel's recommendations for future research. These include:

i) Document catches in Mexican waters by both U.S. and Mexican fishers and consider the implications of blackgill rockfish being a shared stock. Information on biology, life history and exploitation of blackgill in Mexican waters should be sought from Universities or laboratories in Mexico.

ii) Carry out further efforts to reconstruct historical landings and develop alternative catch streams reflecting differences in data quantity and quality available for different time periods.

iii) Investigate alternative means of exploring relative or absolute abundance in the CCA. Submersible or other non-invasive survey methods could potentially provide additional information on habitat and abundance for this species. Also, it is important to develop alternative methods to monitor length and age compositions of fish inside CCA.

iv) Improve age data quality through validation studies and otolith exchanges between labs, and explore possible differences in age and growth throughout the range of this stock using the data from otoliths that have not yet been processed. The collection of the otoliths should be reviewed to ensure they are from representative sampling.

I also make the following recommendations:

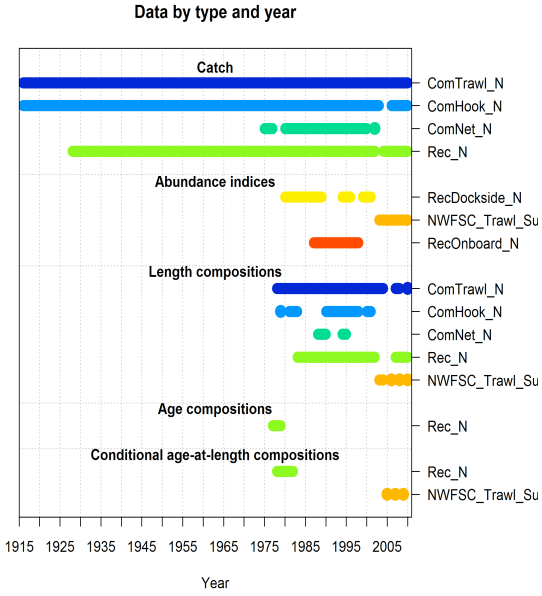
v) Construction of larval indices from the CalCOFI survey, using identifications based on DNA, to help evaluate the long-term trends in spawning output from the SS3 model.

. 4.2 Greenspotted rockfish assessment

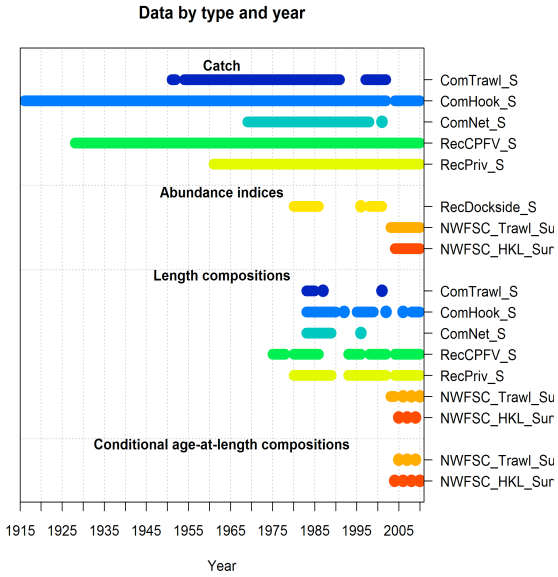
4.2.1 Quality of data used in the assessments including data collection and processing.

The time series of data available for the northern and southern assessment are shown in the following plots provided by the STAT:

Northern stock



(b) Southern stock



Landings data

The core data for this assessment, the fishery landings series, appear adequate for input to the assessment. The early catch history from 1916 – 1968 has been reconstructed as part of a larger exercise to recover historic catch data (Ralston et al, 2010), and will be subject to some error related to the methods and errors of reconstruction which will add uncertainty to depletion estimates.

The catch data used in the assessment includes hook and line discards estimates from observer data for 2002 – 2010, applied historically, and applied also to fixed nets in all years (for which no observations were available). The STAT had doubts about how representative the (very variable) trawl discards estimates were, and chose to estimate this internally to the model. It is likely that the treatment of discards based on such limited data introduces another layer of uncertainty into the assessment which is not fully explored other than applying a fixed ratio of 0.06 for trawls as a sensitivity test.

Recreational survey catches and compositions
Recreational data are an important input to the assessment, particularly as the commercial landings have declined to only ~1 tonne in recent years. The assessment uses recreational catches (incl. dead discards), abundance indices, and length frequencies from CPFV and private/rental boats for various periods since the 1970s (excluding some years with missing data). Catch data are extended back to 1928 using results from Ralston et al. (2010), and including some linear interpolation to estimate private boat catches up to 1979. Discards estimates appear very variable and have uncertainties regarding recalled species identification. Overall the recreational fishery data are probably adequate for use in the assessment but will have historical uncertainty related to survey design, interpolations and species identification. Possible ranges of uncertainty need to be explored.

Length data for recreational catches are available from the 1975 (south) and 1978 (north) sampling and are combined CPFV and private/rental in north and separate in the south. Sample sizes for CPFV or private/rental are relatively high for some time periods and poor for others. Possible sampling problems are evident in very noisy or unusual length compositions in some years particularly where sample numbers are low. However, for the northern CPFV and combined CPFV/private boats, a coherent, progressive decline in mean length is apparent over time, with increasing representation of smaller fish up to the 1990s and a truncation of the upper part of the length compositions. These trends have to be explained in the model as changes in selectivity, as recruitment has to either remain constant or decline in the recent period according to the assumed Beverton-Holt steepness parameter. The trend is not evident in the limited private/rental data for the north.

Some unconditional age composition and conditional age-at-length data from the northern recreational catches are used in the assessment, but only for a few years from 1977-82. The report does not evaluate how representative these are of the overall recreational catches.

Abundance indices.
Abundance indices are of variable duration in the north and south and annual indices have wide confidence intervals.
Northern CDFG onboard: no discernible trend from 1987-1998
Northern RecFIN index: 1999-2001 GLM indices similar to 1980-1988 with low values 1989 & 1994-96.
Southern RecFIN index: very variable but similar indices in 1980s to 2000's
NWFSC trawl, north: no clear trend 2003 0 2010 but very large confidence intervals.
NWFSC trawl, south: increasing trend 2003 – 2007, low values 2008 & 2009; increase again 2010.
A direct relationship between abundance indices and fish abundance (i.e. constant catchability) is not proven for any of the series. Overall, the abundance indices appear relatively uninformative in the northern and southern SS3 model fits and contribute little to the total likelihood which is swamped by the composition data.

Fishery length composition data
The model uses combined-sex fishery length compositions for various periods since the mid 1970s. The data are patchy, and for some gear / year combinations the numbers of samples are low or non-existent. As may be expected, recent sampling is at a very low rate (recent landings are extremely small). A long series of commercial trawl data are available for the northern stock, and although noisy, show a similar trend of declining mean length and increasing incidence of smaller rockfish from the 1980s through to the mid 1990s, observed in the recreational data and also in blackgill rockfish. This is also apparent in hook-and-line samples from the north.

The data appear borderline for use in a predominantly length-based model, and indeed the STAT considered the data inadequate to allow annual recruitment deviations to be estimated. Where only a few trips are sampled in a year, the length frequencies may be poorly representative of the overall fishery, particularly given the depth-related trends in fish size.

Age data
Greenspotted rockfish are acknowledged as being difficult to age. Efforts have been made to increase the number of age data available, and to validate the age estimates and examine consistency in ageing. However the variability observed in the conditional age data is likely to include significant component of age errors, particularly for older fish. The age data are available only from surveys in the last few years in the south and north, with a few years of survey and recreational data for the north from the late 1970s. Growth parameters are estimated externally for the north but estimated in the model for the south. However the two data sources for the south exhibit different growth patterns. The growth parameters are assumed constant over the full period of the assessment which may not be correct given the apparent large stock depletion and the very long period over which the assessment runs.

Main signals in the data
The historical sampling data provide some robust information on aspects of biology important to understanding productivity of the stock:

- Age samples show historical survival of fish to around 50 years of age indicating low rates of mortality.
- Sexual dimorphism in growth is not apparent.
- Length at age data define the general pattern of growth over the age range containing the bulk of the data, but observations towards the asymptotic part of the growth curve are sparse and this limits the ability to accurately estimate VB parameters K and $L_{infinity}$.
- The north and south stocks appear to reach around the same length at 50 years of age, but the rate of growth appears faster in the north.
- 50% maturity in females occurs at L= 26.2 cm in the north and 21.5cm in the south, equivalent to around 10-15 years of age.
- Relative fecundity (eggs or larvae per unit body weight) increases with increasing fish size.

The main temporal signals for stock development in the data for this stock, which affect the model fit, are:

- Total commercial and recreational fishery statewide removals increased from < 100 t up to the mid 1960s to around 400t in the early 1980s and have declined to less than 20t in the 2000s when the stricter commercial trip limits were introduced followed by the Cowcod Conservation area (CCA) in 2001. The growth, peak and decline in catches since the mid 1960's was around a decade earlier in the south than in the north.
- It is known that the rockfish fisheries expanded into deeper water as they developed, which affects species and size compositions and fishery selectivity.
- Fishery selectivity is expected to have been altered by shifts in fishing patterns following the spatial closures.
- Survey and recreational abundance indices are noisy and do not show any clear trends.
- Commercial and recreational fishery length compositions in the north show a progressive reduction in mean length from the 1980s through the 1990s, caused by a truncation at the upper end of the length compositions and an increasing occurrence of smaller fish. This is also observed in blackgill rockfish data.

4.2.2 Evaluation and comment on analytic methodologies.

The SS3 model is an appropriate approach to fitting the available data for this stock, conditional upon identifying model configuration and parsimony appropriate to the quality and information content of the data. The STAT used the SS3 model to fit the commercial and recreational fishery length compositions (and age compositions where available), conditional age-at-length data, and any survey abundance indices, as closely as possible by adjusting a range of parameters such as natural mortality and stock-recruit steepness (fixed externally), and fishery and survey selectivity (e.g. for logistic, double logistic, double normal, as specified by user), growth parameters (south only), standard deviation of length at age and stock-recruit R_0 (estimated internally).

4.2.3 Evaluation of model assumptions, estimates, and major sources of uncertainty; suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.

Model evaluation

By fixing annual recruitments as deterministic predictions from a fitted Beverton-Holt stock recruit function, and assuming constant natural mortality and growth, the assessment is bound to estimate a rapid depletion of biomass as the fishery catches increased in the 1970s. There is no possibility to explain any of the growth in the fishery as resulting from year class variations in earlier years.

A further consequence of fixing the main variables representing stock productivity, particularly year class strength, is that changes in length compositions can only be explained

in the model by adjustments to fishery and survey selectivity patterns and blocking of selectivity over time. For example, as in blackgill rockfish, the lower 10th percentile of the length compositions in several data sets declines over time during the 1980s-1990s, whilst the upper lengths also become more truncated. Potentially, the increasing prevalence of smaller fish could be a reflection of changes in recruitment rather than changes in fishery selectivity, for example due to reductions in intra-guild predation on pre-recruit fish as the rockfish populations were fished down in the 1980s. Furthermore, the decision of the STAT not to explore the use of other stock-recruit model formulations (e.g. Ricker or more flexible forms such as the Shepherd model) further constrains the range of possible interpretations of the data.

There is an *a-priori* basis for assuming some change in selectivity, but selectivity will be confounded with recruitment in explaining changes in length. However, the estimation of annual recruitment should be carried out as soon as the data series are considered adequate.

Against these limitations, the assessment uses the most up-to-date external information to inform the parameters in the model.

I agree with the overall STAR Panel conclusion that natural mortality (which strongly covaries with growth parameters and depletion) is a major source of parameter uncertainty in the SS3 model. The natural mortality values for greenspotted rockfish estimated using different methods are available from Benet et al. (2009). In the assessment, the mean value (0.065) of those estimates was used for both area models. The ranges of *M* reported in Benet et al (2009) were approximately from 0.05 to 0.08. This range was interpreted as a 90% confidence interval of a normal distribution (mean=0.065, std. dev. =0.00912), and high and low states of nature for the decision table were defined based on *M* values (used in base models) plus and minus 1 standard deviation from the mean (M = 0.056 and M = 0.074 were used for low and high states of nature respectively). Following the STAR meeting, the STAT suggested that this provides a rather conservative range for alternative states of nature which will require further consideration for the final management advice. However, it is likely that the true uncertainty in the assessment results is much greater than for this range of *M* alone.

Technical deficiencies, unresolved problems and major uncertainties

This assessment is based on very limited amount of data and, therefore, many parameters cannot be estimated (*M*, *h*, growth, recruitment deviations), which limits the extent of uncertainty estimated within the model. The model therefore, requires careful and extensive sensitivity testing and profiling.

It is not known whether greenspotted rockfish in U.S. and Mexican waters are part of the same stock. It is also not known what portion of the population resides in Mexican waters and what their biological and life history characteristics are.

As with most of the west coast rockfish species, catch history is one of the major sources of uncertainty. Even with the California rockfish catch reconstruction effort reported in Ralston et al. (2010), uncertainty in historical landings remains due to fact that fishing effort

exhibited a gradual shift towards deeper waters. Species composition sampling in Southern California began only in the late 1970s, and these compositions were applied to historical landings of multi-species market categories. Therefore, there is the potential to overestimate the historical contribution of slope species to overall landings of mixed-species market category (i.e. unspecified rockfish), and underestimate the contribution of shelf species, such as greenspotted rockfish.

The Cowcod Conservation Area is closed to research survey trawling. Different rates of population growth inside and outside the CCA may result in the overall survey indices no longer representing the true population trends.

The assessment treats the resource as two separate stocks, geographically stratified south and north of Point Conception with no linkage between the two areas. The break point between stocks was largely selected based on differences in regional exploitation history and general biogeographic considerations, as well as potential differences in growth and maturity. Further study is needed to validate regional differences in biological parameters for this species. In the absence of information on greenspotted rockfish population genetics, the uncertainty regarding stock structure of this species remains. It is possible there is only one stock that exhibits a gradual cline in life history parameters, as is observed in other rockfish species on the U.S. west coast.

4.2.4. Determine whether the science reviewed is considered to be the best scientific information available.

There are many limitations imposed on the greenspotted rockfish assessments due to deficiencies in the data. It is likely that the assessment provides a correct overall picture of a rapid stock decline as the fishery grew in the 1970s, followed by a more recent growth as the fishery has become more restricted. However, the true trajectory of stock biomass or reproductive output must be considered imprecisely known. Although a number of axes of uncertainty were explored (e.g. M and steepness), the assessment is based on only one modelling framework and sensitivity to some model choices (such as stock-recruit model) were not explored. Also, key estimates such as growth parameters and fishery selectivity from more recent data are propagated back in history, including into a period of uncertain fishery catches.

The pre-STAR document as well as the STAT presentation at the STAR Panel provided extensive information on ecosystem considerations for greenspotted rockfish, which (although not explicitly included in the assessment model) provided valuable background information and outlined potential areas of research to pursue in the future while moving toward ecosystem-based management.

4.2.5 Specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.

I agree with the STAR Panel's recommendations for future research. These include:

i) Document catches in Mexican waters by both U.S. and Mexican fishers and consider the implications of greenspotted rockfish being a shared stock. Information on biology, life history and exploitation of this species in Mexican waters should be sought from Universities or laboratories in Mexico.

ii) Carry out further efforts to reconstruct historical landings and discards, and develop alternative catch streams reflecting differences in data quantity and quality available for different time periods.

iii) Investigate alternative means of exploring relative or absolute abundance in the CCA. Submersible or other non-invasive survey methods could potentially provide additional information on habitat and abundance for this species. Also, it is important to develop alternative methods to monitor length and age compositions of fish inside CCA.

iv) Improve age data quality through validation studies and otolith exchanges between labs, and explore possible differences in age and growth throughout the range of this stock using the data from otoliths that have not yet been processed. The collection of the otoliths should be reviewed to ensure they are from representative sampling.

v) Further explore stock structure and spatial variability of life history parameters of greenspotted rockfish, since currently only limited (or not species-specific) information is available.

vi) Explore alternative model structures to account for spatial pattern in species biology, including the model with one stock assumption, model with two areas (with linkage between areas), several growth assumptions and others. Given this recommendation, the Panel suggested conducting a full assessment next time the species is assessed to allow exploration of model structure (which would be impossible in the case of an update assessment).

I also make the following recommendations:

vii) Construction of larval indices from the CalCOFI survey, using identifications based on DNA, to help evaluate the long-term trends in spawning output from the SS3 model.

5. Conclusions and recommendations

5.1 Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Detailed PowerPoint presentations on data and assessments for the two species were given to the STAR Panel, and issues were discussed during each presentation. The Panel requested additional presentations of data or model analyses to clarify issues and to further explore the sensitivity of the models to particular assumptions or parameter estimates. This resulted in some adjustments towards a final agreed base case model for each stock. Final sets of runs were then requested to explore sensitivity of the final base case models to axes of uncertainty

such as *M* and stock-recruit steepness, and to agree the final alternative states of nature to present.

Pertinent discussions included *inter alia* how to present uncertainty in the model results (a recommendation from Alec MacCall to apply the delta method was tried); how the model results are affected by correlation between natural mortality, growth, selectivity and recruitment; tensions between age and length data; accuracy of the recovered historical catch data given known trends in the fishery; appropriateness of splitting green spotted rockfish into two stocks.

A major problem with this STAR Panel was the very large amount of information being presented, effectively for three separate stocks, including large numbers of sensitivity tests. Although the SS3 models were simplified, a lot happens in the models in terms of selectivity curves for multiple commercial and recreational fleets, growth parameter fits (including parameters like length at A_{min} and standard deviation of length at age), and length and age composition fits. Keeping track of all this was extremely difficult, particularly with a lot of flicking back and forth between PowerPoint pages to compare runs. Towards the end of the meeting, the presenters began to put comparative diagnostics onto individual PowerPoint slides, as requested by the Panel, and this improved the clarity of the process. This should be done as standard practice in future such reviews.

5.2 Critique of the NMFS review process, including suggestions for improvements of both process and products

In my experience, the NMFS review process succeeds in its goal of ensuring the assessments under review are capable of providing credible management advice. In general, major errors or problems come to light, and appropriate additional requests are made from the Panel to ensure the management advice is well supported by evidence. Problems can arise if the Panel is presented with too many stocks that are complex to understand and still require extensive sensitivity testing. The blackgill rockfish and greenspotted rockfish review suffered this problem and reduced the time available for drafting the Panel report and discussing the issues amongst the Panel. The final STAR Panel report was a fair view of the Panel's conclusions, but my feeling was that we had not fully explored the uncertainties in the assessment.

A drawback of the review process focusing on independent assessments of species such as rockfish, that are part of a complex of (in this case *Sebastes*) species, is that commonalities in the data for all the species, that could be helpful for interpretation, are not evident. Some similarities between blackgill rockfish and greenspotted rockfish data were apparent (e.g. declining mean length). However it would be useful if the background to the assessment could more clearly highlight the patterns evident in all the species with assessments, particularly in relation to the development of the fisheries and spatial patterns in the populations.

6. References cited

Benet, D. L., E. J. Dick, and D. E. Pearson. 2009. Life history aspects of greenspotted rockfish (*Sebastes chlorostictus*) from central California. NOAA Technical Memorandum NMFS, NOAA-TM-NMFSSWFSC-466.

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Helser, T. 2006. Stock Assessment of the Blackgill Rockfish (*Sebastes melanostomus*) Population off the West Coast of the United States in 2005. In Volume 5: Status of the Pacific Coast Groundfish Fishery Through 2005, Stock Assessment and Fishery Evaluation Portland, OR: Pacific Fishery Management Council.

Moser, H. G., Charter, R. L.,Watson, W.,Ambrose, D. A.,Butler, J. L.,Charter, S. R., Sandknop,E. M. 2000. Abundance and distribution of rockfish (*Sebastes*) larvae in the Southern California Bight in relation to environmental conditions and fishery exploitation. CalCOFI Reports 41: 132-147.

Ralston,S., Pearson, D., Field, J., M. Key, M. 2010. Documentation of the California commercial catch reconstruction project. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-461.

Appendix 1 Material provided for review

Field, J.C. and Pearson, D. 2011. Status of the blackgill rockfish, *Sebastes melanostomus*, in the Conception and Monterey INPFC areas for 2011.

Dick, E.J., Pearson, D. and Ralston, S. 2011. Status of Greenspotted Rockfish, *Sebastes chlorostictus*, in U.S. waters off California

Additional background documents were placed of the ftp site.

Appendix 2: Statement of Work for Dr. Michael Armstrong (CEFAS)

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Review (STAR) Panel for greenspotted rockfish and blackgill rockfish

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: A benchmark assessment is proposed for Blackgill rockfish, another highly vulnerable species, and a major component in the Southern Slope Rockfish complex. It has not been assessed since the first effort in 2005. A new assessment is planned for proposed for greenspotted rockfish because it is at the high end of the PFMC's precautionary range developed by the GMT, and the SWFSC has already expended considerable effort in organizing and analyzing data for this species. Assessments for these two stocks will provide the basis for the management of the groundfish fisheries off the West Coast of the U.S. including providing scientific basis for setting OFLs and ABCs as mandated by the Magnuson-Stevens Act. The technical review will take place during a formal, public, multiple-day meeting of fishery stock assessment experts. Participation of external, independent reviewer is an essential part of the review process. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Two CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in fish population dynamics, with experience in the integrated analysis modeling approach, using age-and size-structured models, use of MCMC to develop confidence intervals, and use of Generalized Linear Models in stock assessment models.
Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Santa Cruz, California during 8-12 August 2011.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in Santa Cruz, California during 8-12 August 2011.
3) In Santa Cruz, California during 8-12 August 2011 as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 26 August 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net and to Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

5 July 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
25 July 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
8-12 August 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
26 August 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
9 September 2011	CIE submits CIE independent peer review reports to the COTR
16 September 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

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Michelle McClure
National Marine Fisheries Service, 2725 Montlake Blvd. E, Seattle WA 98112
Michelle.McClure@noaa.gov

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Stock Assessment Review (STAR) Panel for greenspotted rockfish and blackgill rockfish

1. Become familiar with the draft stock assessment and background materials.
2. Comment on the quality of data used in the assessments including data collection and processing.
3. Evaluate and comment on analytic methodologies.
4. Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.
5. Determine whether the science reviewed is considered to be the best scientific information available.
6. Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.
7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Annex 3: Tentative Agenda

Stock Assessment Review (STAR) Panel for greenspotted rockfish and blackgill rockfish

Santa Cruz Lab, NMFS Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060

August 8-12, 2011

Finalized agenda will be provided by NMFS project contact two weeks before the review.

Monday, August 8, 2011

9:00 a.m.	Welcome and Introductions
9:15 a.m.	Review the Draft Agenda and Discussion of Meeting Format (Panel Chair)
	- Review Terms of Reference for Assessment and Review Panel
	- Assignment of reporting duties
	- Discuss and agree to format for the final assessment document
9:45 a.m.	Stock Assessment Team (STAT-1) Presentation of Species 1 (Authors)
	- Overview of Data and Stock Synthesis Modeling
12:30 p.m.	Lunch (On Your Own)
1:30 p.m.	Q&A session with the STAT-1 & Panel discussion
3:30 p.m.	Coffee Break
3:45 p.m.	Panel develops request for additional model runs / analyses for STAT 1
4:30 p.m.	Panel provides written requests for additional model runs / analyses to STAT 1
5:00 p.m.	Adjourn for day.

Tuesday, August 9, 2011

9:00 a.m.	Stock Assessment Team (STAT-2) Presentation of Species 2 (Authors)
	- Overview of Data and Stock Synthesis Modeling
12:00 p.m.	Lunch (On Your Own)
1:30 p.m.	Q&A session with the STAT-2 & Panel discussion
3:00 p.m.	Coffee Break
3:15 p.m.	Panel develops request for additional model runs / analyses for STAT 2
4:00 p.m.	Panel provides written requests for additional model runs / analyses to STAT 2
4:30 p.m.	Panel check in with STAT-1 if needed
5:00 p.m.	Adjourn for day.

Wednesday, August 10, 2011

9:00 a.m.	STAT-1 Presentation of first set of model runs for Species 1

- Q&A session with the STAT-1 & Panel discussion
- Panel develops written request for second round of model runs / analyses for STAT 1

12:00 p.m. Lunch (On Your Own)

1:30 p.m. STAT-2 Presentation of first set of model runs for Species 2

- Q&A session with the STAT-2 & Panel discussion
- Panel develops written request for second round of model runs / analyses for STAT 2

3:30 p.m. Coffee Break

3:45 p.m. Continue Panel discussion with STAT-2

5:00 p.m. Adjourn for day.

Thursday, August 11, 2011

9:00 a.m. STAT-1 Presentation of Second Set of Model Runs for Species 1

- Q&A session with the STAT-1 & Panel discussion
- Identification of preferred model and elements for the decision table.
- Panel develops third list of model runs for decision table and begins drafting STAR report.

12:00 p.m. Lunch (On Your Own)

1:00 p.m. STAT-2 Presentation of Second Set of Model Runs for Species 2

- Q&A session with the STAT-2 & Panel discussion
- Identification of preferred model and elements for the decision table.
- Panel develops third list of model runs for decision table and begins drafting STAR report.

3:30 p.m. Coffee Break

3:45 p.m. Panel discussion or report drafting continues

5:00 p.m. Adjourn for day.

Friday, August 12, 2011

9:00 a.m. Consideration of remaining issues

- Review decision tables for Species 1 and Species 2

11:00 a.m. Panel agrees to process for completing final STAR report by Council's September meeting Briefing Book deadline

5:00 p.m. Review Panel Adjourns

Appendix 3: Panel membership

Review Panel Members
Vladlena Gertseva, NMFS NWFSC, Panel Chair, SSC
Mike Armstrong, CIE
Kevin Stokes, CIE
Louis Botsford, UC Davis, SSC

Stock Assessment Team (STAT) Members
John Field, NMFS SWFSC (blackgill assessment)
E.J. Dick, NMFS SWFSC (greenspotted rockfish assessments).

STAR Panel Advisors
Sean Matson, NMFS NWR, GMT
Gerry Richter, PCGFA, GAP
John DeVore, PFMC